

Exhibit 25

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Supplemental Expert Report

Comparison of RI's and Chrysotile Structure Size Union Carbide's SG-210 Chrysotile Product from the Coalinga Mine in California, Montanan Talc Sourced for both Gold Bond and Clubman Body Powder, Fibrous Talc and Reduced size NIST 1866b Chrysotile Standard.

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MAS's PLM Analysis of Chrysotile in Cosmetic Talc

MAS PLM analysis was able to both detect and determine the amount of chrysotile bundles in the sample with HLS because MAS uses PLM microscopes that have higher resolution and analytical sensitivity capabilities, than your standard PLM microscope which is more suited for analyzing asbestos added products (AAP).

In AAP (chrysotile) samples as compared to cosmetic talc samples, have a much higher population of very large size chrysotile bundles and orders of magnitude higher concentration levels of chrysotile in these types of products.

The PLM analysis of AAP samples does not challenge the resolution of the typical PLM microscope optics, or burden the microscopist with very long sample analysis times. For example, in most PLM labs, including MAS's, the typical time required for an experienced PLM microscopist to analyze asbestos added products (AAP), where the majority of the AAP samples contain approximately 10 to 25 % asbestos, will only take about 15 and 20 minutes to complete the analysis.

With a cosmetic talc sample on the other hand, a typical PLM analysis at MAS, for either chrysotile or amphiboles asbestos, would routinely take 2 to 4 hours for a positive sample and a minimum of 20 minutes to hour for a negative sample, if there are no pigments in the sample. In order to both detect and analyze the small size of the chrysotile bundles (10 to 20 μm in length), that are typically found in cosmetic grade talcum powder, through the use of dispersion staining, the PLM microscope must have "flat" objective lenses, and a HD video camera attached to the PLM microscope that is interfaced to a high definition monitor.

The MAS PLM microscopes are state-of-the-art Leica DM2700P PLM microscopes, where all of the objective lens, including the 10X central stop dispersion lens are the flat type, also known as infinity lens, LED light source, and are coupled with state-of-the-art HD digital camera and 37" HD monitor. To detect these size chrysotile bundles, it is highly recommended that this type of PLM microscope setup should be used for the PLM analysis of cosmetic talc samples.

It is also my opinion that the PLM analyst must first analyze prepared talcum powder standards, containing UCC SG-210 or RG-144 Calidria chrysotile, to become familiar with both the size of chrysotile structures found in cosmetic talc, as well as the difference in the refractive indices for the chrysotile as compared chrysotile added products.

Both the RG-144 and RG-210 Calidria chrysotile and the chrysotile found in the talcum powder samples typically shows central stop dispersion colors (CSDS) from blues (α) to golden yellows (γ) in 1.550 liquid, and blue to a darker gold in 1.560 liquid. For the two UCC Calidria chrysotile samples, the SG 210 is a closer match then the RG 144 is to the size of chrysotile bundles detected in the cosmetic talc samples. Photomicrographs of Chinese source cosmetic talc, spiked with 0.05% SG-210 chrysotile, analyzed with 1.560 RI fluid can be found in Section 2 of this report

In Table 1, is a Bentonite clay sample that was spiked with 0.1% UCC's SG-210 chrysotile product showing the parallel and perpendicular RI's, calculated BIR and the length and width of seven chrysotile bundles. These photomicrographs can be found in Section 3 of this report.

Table 1

0.1% SG-210 Spiked Bentonite

1.550 RI Fluid

MAS Sample Number	Sample Prep.	Refractive Induces Parallel	Refractive Induces Perpendicular	Birefringence Avg	Length microns	Width microns
M71547-001	CSM-B O.1%	1.565-1.567	1.554	0.012	6 μm	1 μm
M71547-002	CSM-B O.1%	1.567-1.570	1.551-1.556	0.015	6 μm	1 μm
M71547-003	CSM-B O.1%	1.560-1.569	1.552-1.556	0.011	10 μm	2 μm
M71547-004	CSM-B O.1%	1.564-1.570	1.552-1.556	0.013	9 μm	1 μm
M71547-005	CSM-B O.1%	1.566-1.571	1.552-1.556	0.015	9 μm	1 μm
M71547-006	CSM-B O.1%	1.567-1.570	1.552-1.556	0.015	3 μm	0.6 μm
M71547-007	CSM-B O.1%	1.564-1.572	1.555-1.558	0.012	9 μm	1 μm
		Avg. 1.562-1.570	Avg. 1.553-1.556	Avg. 0.012	Avg. 8 μm	Avg. 1 μm

As this data demonstrated the SG-210 chrysotile product once sold by UCC, has gamma RI ranges that does not produce the "magenta" CSDS color, but instead has variations of the yellow-gold in the 1.550 RI fluid. The Bentonite clay matrix was used for one the SG-210 chrysotile spiked sample sets, so there isn't any fibrous or platy talc to confuse the issue. Platy talc is not known to be an accessory mineral to bentonite clay. Also, according to Dr. Gunter, there is no talc accessory mineral in the Coalinga chrysotile mine.¹ Additionally, Dr. Gunter was shown CSM-B 0.1% PLM photomicrographs in the Loc Ta case, and ask to identify what the mineral was in the photomicrograph, and Dr. Gunter identified it as platy talc plates on edge.² In fact, what Dr. Gunter was identifying as talc plates on edge, was the bentonite clay sample spiked with the 0.1% SG-210 chrysotile. This will be discussed in more detail in the next section.

Table 2 provides a comparison of the of chrysotile, analyzed using 1.550 RI fluid, shows the RI's, BIR and bundle size for the chrysotile detected in the Montana talc used by Gold Bond. Photomicrographs of the Gold Bond PLM analysis can be found in Section 4 of this report.

¹ April 27, 2023 Deposition of Dr. Gunter, in the *Evan Plotkin and Martha Barry Plotkin vs. Johnson & Johnson*.

² July 8, 2022 Deposition of Dr. Gunter, in the *Loc Ta and Christina Ta vs. Kaiser Gypsum Company, Plotkin and Martha Barry Plotkin vs. Johnson & Johnson*

Table 2
Chrysotile Analysis of Gold Bond
1.550 RI Fluid

MAS Sample Number	Sample Prep.	Refractive Induces Parallel	Refractive Induces Perpendicular	Birefringence Avg	Length microns	Width microns
M71376-001-001	CSM	1.568-1.565	1.562-1.551	0.010	24 µm	2.8 µm
M71376-001-002	CSM	1.568-1.566	1.557-1.553	0.012	4.5 µm	2 µm
M71376-001-003	CSM	1.569	1.556	0.013	13.6 µm	1.2 µm
M71376-001-004	CSM	1.567-1.564	1.558-1.553	0.011	12 µm	1 µm
M71537-001-001	CSM	1.567-1.564	1.562-1.553	0.008	4 µm	2 µm
M71537-001-002	CSM	1.568-1.566	1.552-1.556	0.012	4.4 µm	1.2 µm
M71537-001-003	CSM	1.568-1.566	1.562-1.553	0.012	6.4 µm	2.4 µm
M71537-001-004	CSM	1.572-1.567	1.559-1.552	0.014	7 µm	1.2 µm
		Avg. 1.568-1.565	Avg. 1.559-1.553	Avg. 0.012	Avg. 9 µm	Avg. 1.4 µm

Comparing tables 6 and 7, there is fairly good agreement between the UCC SG-210 chrysotile and the chrysotile detected in the two Gold Bond containers where the talcum powder was sourced from Montana. In my opinion this further demonstrates that chrysotile found in the talcum powder sourced from Montana, has RI's (CSDS) that is in the same range of a commercial mined chrysotile product that does not have a parallel magenta CSDS, but the yellow-gold with a low BIR including the perpendicular RI value.

MAS has been reporting this range of CSDS colors for the chrysotile detected in the cosmetic talc samples for almost two years using 1.550 RI liquid. During that time, defendant experts, retained by a number of cosmetic talc manufacturers, and have repeatedly testified that MAS's CSDS findings are not appropriate for chrysotile. Therefore, in their opinions, MAS was and has been misidentifying fibrous/platy talc edge or cellulose as chrysotile.

Dr. Gunter, while working as a defense expert for Gold Bond defense counsel, analyzed samples of RG-144 and SG-210 Calidria chrysotile, that MAS provided to him, and confirmed in a recent deposition that "Calidria chrysotile can produce a range of CDSC colors from bluish to golden-yellow in 1.550 liquid.³ Dr. Gunter's Calidria chrysotile results are consistent with our laboratories findings, which confirms both our PLM chrysotile findings in the cosmetic talc samples, as well as the SG-210 chrysotile results.

Additionally, Dr. Gunter's testimony about his Calidria CSDS results is in direct contradiction to his original criticism of the "yellow-gold" dispersion color, as well as Dr. Sanchez and Mr. Seagrave's past testimony and their expert reports on this issue.

³ Deposition of Dr. Mickey Gunter, *Woods, Jesse & Sarah vs. Kolmar Laboratories Inc. et al.* Supreme Court in the State of New York, County of Monroe, #E202000384

It is my opinion, that when these defense experts were testifying that our laboratory was misidentifying fibrous talc or talc plates on edge for chrysotile based on the CSDS "yellow color", as it turns out, the opposite was true, they were the ones misidentifying chrysotile as fibrous talc or talc plates on edge.

It is my opinion, that when these defense experts were testifying that our laboratory was misidentifying fibrous talc or talc plates on edge for chrysotile based on the CSDS "yellow color", as it turns out, the opposite was true, they were the ones misidentifying chrysotile as fibrous talc or talc plates on edge.

ISO-PLM Chrysotile Refractive Index Ranges

As shown in Table 3, the range of measured refractive indexes for the detected chrysotile bundles in the fourteen Clubman powder samples was 1.563-1.571 (parallel) and 1.556 to 1.567 (perpendicular) for the average using the CSMP method.

Shown in Table 6 are the range of RI's for the 57 chrysotile bundles that were recorded as examples of the chrysotile detected in the fourteen Clubman powder samples that were prepared by the CSMP method (with HLS).

Table 3
RI Fluid 1.560
Chrysotile
Range of Parallel and Perpendicular RIs

Chrysotile Bundle No.	RI Fluid	CSMP PLM (with HLS) Parallel RI	CSMP PLM (with HLS) Perpendicular RI	BIR Calculations $\gamma - \alpha$
M71598-001	1.560			
1		1.568	1.564	0.004
2		1.566	1.558	0.008
3		1.570	1.563	0.007
4		Avg. 1.567	1.561	0.006
		Avg. 1.568	Avg. 1.562	0.006
M71598-002	1.560			
1		1.569	1.562	0.007
2		1.566	1.561	0.005
3		1.565	1.560	0.005
4		1.571	1.561	0.005
3		1.565	1.560	0.005
		Avg. 1.568	Avg. 1.561	0.005
M71598-003	1.560			
1		1.566	1.562	0.004
2		1.567	1.563	0.004
3		1.565	1.560	0.004
		Avg. 1.567	Avg. 1.562	0.005
M71598-004	1.560			
1		1.565	1.563	0.004
2		1.570	1.562	0.008
3		1.570	1.562	0.008

4		1.567	1.565	0.002
		Avg. 1.568	Avg. 1.563	0.006
M71598-005	1.560			
1		1.566	1.562	0.004
2		1.567	1.562	0.004
3		1.566	1.560	0.006
4		1.570	1.562	0.008
		Avg. 1.567	Avg. 1.562	0.006
M71598-006	1.560			
1		Avg. 1.565	1.560	0.005
2A		1.566	1.558	0.010
2B		1.568	1.561	0.007
3		1.567	1.563	0.004
4		1.568	1.562	0.006
		Avg. 1.567	Avg. 1.561	0.006
M71598-007	1.560			
1		1.568	1.565	0.003
2		1.567	1.560	0.007
3		1.569	1.565	0.004
4		1.567	1.560	0.007
		Avg. 1.568	Avg. 1.563	0.005
M71598-008	1.560			
2		1.569	1.560	0.009
2		1.566	1.562	0.004
2		1.571	1.561	0.010
4		1.567	1.563	0.004
		Avg. 1.568	Avg. 1.562	0.008
M71598-009	1.560			
1		1.571	1.561	0.010
2		1.568	1.560	0.008
3		1.566	1.562	0.004
		Avg. 1.568	Avg. 1.561	0.007
M71598-010	1.560			
1		1.566	1.561	0.005
2		1.565	1.561	0.004
3		1.567	1.562	0.005
4		1.565	1.561	0.004
		Avg. 1.566	Avg. 1.561	0.005
M71598-012	1.560			
1		1.568	1.564	0.004
2		1.567	1.561	0.005
3		1.567	1.562	0.005
4		1.570	1.560	0.010

		Avg. 1.568	Avg. 1.562	0.006
M71598-013	1.560			
1A		1.566	1.562	0.004
1B		1.571	1.560	0.011
2		1.570	1.565	0.002
3		1.568	1.562	0.006
		Avg. 1.569	Avg. 1.562	0.006
M71598-014	1.560			
1		1.566	1.561	0.005
2		1.567	1.562	0.005
3		1.567	1.560	0.007
4		1.566	1.562	0.004
		Avg. 1.567	Avg. 1.561	0.005
M71598-015	1.560			
1		1.570	1.563	0.007
2		1.567	1.564	0.003
3		1.565	1.561	0.004
4		1.570	1.562	0.008
		Avg. 1.568	Avg. 1.563	0.006

Both the RG-144 and SG-210 chrysotile and the chrysotile found in the talcum powder samples typically shows central stop dispersion colors (CSDS) from blues (α) to golden-yellows (γ) in 1.550 liquid, and blue to a dark gold in 1.560 liquid for chrysotile structures in the 5 μ m to 20 μ m in length, and 1 to 3 μ m in width. MAS has been reporting this range of CSDS colors for the chrysotile detected in the cosmetic talc samples for almost two years using 1.550 RI liquid. As discussed above, during that time the defendant experts, retained by a number of cosmetic talc manufacturers, have repeatedly testified that MAS's CSDS findings are not appropriate for chrysotile. Therefore, in their opinions, MAS was and has been misidentifying fibrous/platy talc edge or cellulose as chrysotile. In my opinion, the defendant experts are wrong. The basis for this opinion is as follows:

For a set of Clubman samples, MAS used higher RI fluid (1.560) as discussed by Dr. Gunter, Alan Segrave in their expert reports, and Dr. Su's puzzling photo-shopped expert report, and where they both stated that MAS should use a higher RI fluid than 1.550 to verify that MAS is in fact identifying chrysotile.

MAS analyzed 14 Clubman powder samples chrysotile, instead of using 1.550 RI fluid, MAS used 1.560 RI fluid, for all 14 samples. The reason for this change, is because of the information provided in Dr. Su's 2nd quarter publication in "The Microscope Journal" that in his opinion,

using the 1.560 RI fluid would produce more accurate RI results. This issue is discussed later in this report.

Also, Dr. Gunter, while working as a defense expert for Gold Bond defense counsel, analyzed samples of RG-144 and SG-210 UCC chrysotile, that MAS provided to him, and confirmed in a recent deposition that "Calidria chrysotile can produce a range of CDSC colors from bluish to golden-yellow in 1.550 liquid."⁴ Dr. Gunter's Calidria chrysotile results are consistent with our laboratories findings, which in my opinion validates our PLM chrysotile findings in cosmetic talc samples.

Dr. Gunter's testimony about his Calidria CSDS results is in direct contradiction to his original criticism of the "yellow-gold" dispersion color in the gamma direction, as well as Dr. Sanchez and Mr. Seagrave's past testimony on this issue.

Additionally, in that same publication Dr. Shu-Chun Su states the following in his article;

"For high-accuracy measurements such as regulatory, legal, and forensic analysis, etc., the rule of thumb is to choose RI liquids as close as possible to the RI's that will be measured. For Example, there are chrysotile minerals whose RIs are significantly higher than those of the standard chrysotile from the NIST SRM 1866 set. In that case, 1.555 or 1.560, instead of 1.550 RI liquids should be used to determine γ "⁵

The range of gamma RI's we are seeing in the cosmetic talc is approx. 1.560 to 1.570, and with an average of typically 1.565 to 1.567, this range of CSDS fits into Dr. Su's reasoning for using 1.560 RI fluid instead of the 1.550. The Dr. Su article is the main reason we are now using 1.560 RI fluid for talcum powder chrysotile analysis instead of 1.550 RI fluid. Also, this article provided asbestos wavelength to RI charts for the various asbestos types and one for using 1.560 RI fluid for the analysis of chrysotile.

Additionally, Dr. Su, publishing a peer reviewed article on the analysis of asbestos by PLM, acknowledging that some types of chrysotile minerals will have significantly higher RI's, then the NIST 1866b chrysotile standard. Our cosmetic talc chrysotile analysis, as well as the SG-210 chrysotile both have higher RI's in the parallel direction then what is seen for the NIST 1866b chrysotile standard. With this statement, Dr. Su is acknowledging, that not all chrysotile minerals with have the magenta dispersion color, but not everybody understands this concept.

⁴ Deposition of Dr. Mickey Gunter, Woods, Jesse & Sarah vs. Kolmar Laboratories Inc. et al. Supreme Court in the State of New York, County of Monroe, #E202000384

⁵ Shu-Chun Su, Ph.D., "The Dispersion Staining Technique and Its Application to Measuring Refractive Indices of Non-opaque Materials, with Emphasis on Asbestos Analysis", The Microscope Volume 69, Second Quarter, 2022.

For example, I believe that both Dr. Sanchez's and Alan Seagrave's opinions are that chrysotile is always going to produce a magenta dispersion in the gamma direction, and that it can't have the higher RI's in the gamma direction giving a CSDS yellow-gold in 1.550 RI fluid. Nevertheless, it now been verified by both Dr. Sanchez's Ph.D. and his Ph.D. Professor Dr. Gunter, and Dr. Su stating that chrysotile can have higher CSDS then found for the NIST 1866b chrysotile standard.

So, the question we have recently tried to an answer is question of "why the higher gamma RI's for both the SG-210 chrysotile and cosmetic chrysotile we have identified in the cosmetic talcs, then the typical gamma RI's CSDS magenta color produced by the NIST 1866b chrysotile standard?

First, we examined what could have caused this shift to higher gamma RI's between the UCC's SG-210 chrysotile product, and the chrysotile found in the cosmetic talcs as compared to the NIST 1866b chrysotile standard. This investigation resulted in findings that the primary reason for the SG-210 and the chrysotile detected in the cosmetic talcs to have higher CSDS is because of the size difference between the NIST 1866b chrysotile standard along with the overwhelming majority of chrysotile add products. The most probable reason for the difference in CSDS colors is the chrysotile structure size difference between what is found in cosmetic talcs and what is found in chrysotile added products.

To determine if it was the size of the chrysotile bundles found in the cosmetic talc and SG-210 as compared to the size of the bundles found in chrysotile added products, could affect CSDS colors, the following observations were made.

The ISO 22262-1 PLM analysis protocol shows a photograph of the chrysotile CSDS colors using RI fluid 1.550. The parallel direction shows the magenta color and the perpendicular direction shows a purplish-blue color. The size of the chrysotile bundle shown for ISO 1866b chrysotile standard has a visible length of at least 3 to 4 millimeters and approx. 300 to 400 μm wide. When compared to the size of the SG 210 and the chrysotile found in the cosmetic talcs, the length and width of the chrysotile bundle displayed in the ISO 22262-1 protocol, is hundreds to thousands of times longer than the length and width of the chrysotile found in the cosmetic talc products.

The reason for this chrysotile size difference is either the cosmetic chrysotile bundles were formed that way, along with the talc plates, and or because both the SG-210 and talc ore was reduced in size during the milling process, while the NIST 1866b chrysotile standard was probably not.

To test this hypothesis that the thickness of the chrysotile bundle could affect the CSDS colors, MAS performed a study where a one-gram sample from the NIST 1866b chrysotile standard was milled with a liquid nitrogen ball-mill for 25 minutes. This milling process reduced the overall size range of the NIST chrysotile standard that produced a minus 200 sieve size chrysotile bundles fraction along with a plus 200 size fraction. The minus 200 particle size 1866b fraction was removed and analyzed by PLM using both 1.550 and 1.560 RI fluid.

The results of the PLM analysis, using 1.550 RI fluid of the minus 200 size 1866b chrysotile showed higher refractive indices for the parallel direction for what is the expected range for the NIST 1866b chrysotile as shown in Tables 3 and 4 in the ISO 22262-1 PLM method. The reported RI's for the non-reduced 1866b chrysotile standard was between 1.556 to 1.552 for the parallel direction, and 1.544 to 1.549 for the perpendicular direction. Comparison RI's for the minus 200 sieved 1866b chrysotile to the ISO 22262-1 ranges are shown in Table 4. The photomicrographs for the 1866b reduced bundle size, analyzed with 1.550 RI fluid, can be found in Section 5 of this report.

Table 4
Comparison of IRs for Reduced size 1866b chrysotile
to ISO 22262-1 chrysotile RI's
1.550 RI Fluid

Sample #	Reduced size 1866b Gamma	ISO 22262-1 Gamma	Reduced size 1866b Alpha	ISO 22262-1 Alpha	BIR Calculations
1	1.562	1.556-1.552	1.550	1.554-1.549	0.012
2	1.560	1.556-1.552	1.549	1.554-1.549	0.011
3	1.562	1.556-1.552	1.552	1.554-1.549	0.010
4	1.562	1.556-1.552	1.547	1.554-1.549	0.014
5	1.562	1.556-1.552	1.547	1.554-1.549	0.014
6	1.557	1.556-1.552	1.549	1.554-1.549	0.018
7	1.563	1.556-1.552	1.551	1.554-1.549	0.012

As can be seen from the above comparison, the reduced size 1866b chrysotile standard gamma RI's are all higher than what is thought to be required for identifying chrysotile. Also, the reduced size 1866b gamma RI's, are in the range with the chrysotile we have been identifying in numerous talcum powder samples over the last few years. For the alpha direction, the MAS results in the past, has either overlapped for what is expected for the 1866b chrysotile standard or has had RI's in the range as shown in Table 5.

The reduced sizes 1866b chrysotile was also analyzed by PLM with 1.560 RI fluid. For the parallel direction, the range of Gamma was 1.559 to 1.562 and 1.554 to 1.557 for the perpendicular direction. These results are shown in Table 5. The photomicrographs for the 1866b reduced bundle size, analyzed with 1.560 RI fluid, are the same photomicrographs in Section 6 of this report.

Table 5
Comparison of IRs for Reduced size 1866b Chrysotile
to ISO 22262-1 chrysotile RI's
1.560 RI Fluid

Sample #	Reduced size 1866b Gamma	Reduced size 1866b Alpha	Length -Width microns	BIR Calculations
1	1.560	1.557	1.04 – 0.39	0.003
2	1.562	1.557	2.18 – 0.25	0.005
3	1.560	1.557	2.02 – 0.27	0.003
4	1.559	1.556	3.33 – 0.55	0.003
5	1.560	1.554	1.22 – 0.20	0.006

Since MAS has been reporting the findings of chrysotile in cosmetic talc, both Dr. Sanchez and Mr. Seagrave have repeatedly issued expert reports and testified that MAS has been misidentifying fibrous talc as chrysotile. They based this opinion on the fact that our CSDS colors were not magenta for the gamma direction, caused by the reported higher RI's. Their opinions were along the lines that for identifying chrysotile with PLM, if it didn't have CSDS magenta dispersion color in the gamma direction, it was not chrysotile.

It is my opinion that the reduced sieve size 1866b chrysotile clearly shows that they are wrong. Therefore, it is my opinion, that when these defense experts were testifying that our laboratory was misidentifying fibrous talc or talc plates on edge for chrysotile based on the CSDS colors that were not magenta for the gamma direction, as it turns out, the opposite was true, the defense experts were the ones misidentifying chrysotile as fibrous talc or talc plates on edge.

The reduced size 1866b chrysotile RI's in 1.560 fluid are in the same range as the reduced 1866b RI's in the 1.550 fluid. Hence, none of the 1886b reduced size chrysotile bundles have

the magenta dispersion color in the gamma direction as shown for the very large chrysotile bundles photomicrographs shown in the ISO 22262-1 PLM method. This comparison of the reduced size 1866b chrysotile standard RI's to the chrysotile bundle RI's detected in the 14 Clubman samples is fairly close, and in my opinion, validations that the chrysotile detected in Clubman samples was correctly identified as chrysotile. Additionally, this data further supports my opinion that by reducing the size of the chrysotile bundles effects the CSDS colors by increasing the refractive induces in the gamma direction

Birefringence Measurements

The key optical property to differentiate fibrous talc from chrysotile asbestos, when using the PLM method, is determining the difference in the birefringence (BIR) value between these two elongated minerals. Most PLM analysts will just use the PLM cross-polar condition to visually estimate the magnitude of the BIR (Low, Moderate or High) by the amount of brightness and change in wavelength colors that are observed.

This visual estimate of the amount of birefringence is typically done under cross-polar conditions where a subjective comparison is made by the PLM analyst, and therefore, is not very precise. A more accurate determination of BIR is to calculate the numerical BIR value by simply subtracting the measured perpendicular RI from the measured parallel RI ($n_{||} - n_{\perp}$).

The subtracted BIR results give the analyst a numerical birefringence (BIR) value that is either classified as **Low (<0.01)**, **Moderate (0.01 to 0.05)** and **High (>0.05)**.

Fibrous talc and/or talc plates on edge will have a calculated BIR value that is typically at the high end of Moderate (0.045) to greater than 0.05 which is in the High BIR range. Chrysotile on the other hand, will have BIR values that range from the upper end of the Low range to the lower end of the Moderate range. The average calculated range of BIRs (Table 3), for the detected chrysotile bundles from the fourteen Clubman powder samples for CSMP PLM method was **0.005 to 0.008 (avg. 0.007)** which falls in the low end of BIR classifications. When the BIR was calculated for each of the 56 individual chrysotile bundles shown in Table 6, the approximate BIR was calculated to 0.006 that is again in the range published by the EPA in their PLM bulk method discussed below.

The BIR difference between fibrous talc and chrysotile, as demonstrated by MAS, is also verified by the EPA in their 600/R-93/116 PLM methodology document as shown in Table 2-2, page 21.⁶

Shown in Table 2-2, "Optical Properties of Asbestos Fibers", provides four sets of refractive indexes measured from chrysotile bundles that have an overall average BIR of 0.011. This is in good agreement with the overall **MAS BIR avg range of 0.006 to 0.007** for the chrysotile

⁶ U.S. Environmental Protection Agency "Method for the Determination of Asbestos in Bulk Building Materials" EPA/600/R-93/116 July 1993

bundles detected in the fourteen Clubman powder samples for CSMP sample preparation method.

In that same table, EPA published a range chrysotile BIR's of 0.004 to 0.017 (Low to moderate). This BIR range reported by EPA, was from the Maximum and Minimum values obtained from references 2, 11, 12, and 18 located in Section 22.

The EPA R93 protocol also provides RI and BIR data for both fibrous talc and Flat Cellulose Ribbons that can be found in their Table 2.5. For the RI's of fibrous talc example, EPA reports refractive index 1.600-1.540 with a measured BIR of 0.06, and for cellulose ribbons, the reported EPA RI's are 1.580-1.530 with a measured BIR of 0.05 as shown in Table 6.

Table 6

EPA-R93: Optical Properties of Selected Fibers

Fibrous Talc & Cellulose Ribbons

Fiber Type	RI Parallel/Perpendicular	BIR Calculations
Fibrous Talc	1.600-1.540	0.060 "High"
Cellulose	1.580-1.530	0.050 high end of Moderate

MAS has analyzed a significant number of talc fibers over the last two years under the exact same PLM conditions as the chrysotile bundles in the cosmetic talc (same RI fluid, same microscope conditions, and the brightness level at maximum intensity. Shown in Table 10, is the PLM analysis of Chinese sourced talcum powder of fibrous talc that was analyzed in 1.560 fluid. Photomicrographs of the fibrous talc PLM analysis can be found in Section 6 of this report.

Table 7

**Fibrous Talc Analysis of Chinese Talcum Powder
Spiked with 0.05% SG-210
RI Fluid 1.560**

MAS Sample Number	Sample Preparation	Refractive induces Parallel	Refractive indices Perpendicular	Calculated BIR
Sample 1	CSM	>1.595	<1.550	>0.045
Sample 2	CSM	>1.590	<1.550	>0.040
Sample 3	CSM	1.590	<1.550	>0.045
Sample 4	CSM	>1.595	<1.550	>0.045
				>Avg. 0.045

The avg. of >0.045 for the fibrous talc as compared to 0.007 calculated for the chrysotile detected in the Clubman samples is greater than 6 times higher for the fibrous talc or talc plates on edge. This data is consistent with the fibrous talc BIR that EPA published in their R93-600

PLM method as shown in Therefore, it is opinion that any competent PLM analyst can easily distinguish between these two minerals.

For a visual demonstration showing the significant difference between chrysotile bundles and fibrous talc our talc plates on edge, MAS has recorded photomicrographs of chrysotile and talc intergrowths where one portion of bundle is chrysotile and one portion fibrous talc. Obviously, since these are intergrowths and are on the same photomicrographs, then the brightness conditions of the microscope have to be the same, which is the brightness is at maximum. Shown in Table 8, are the RI's for fibrous talc-chrysotile intergrowth bundles that were analyzed by PLM using 1.550 RI Fluid. The photomicrographs for this analysis can be found in Section 7 to this report.

Table 8
Fibrous Talc Chrysotile Intergrowths
M71222
RI Fluid 1.550

MAS Sample Number	RI's Chry $\gamma - \mu$	BIR Chry	RI's Talc $\gamma - \mu$	BIR Talc
M71222-005ISO-002	1.564-1.550	0.014	>1.590-1.540 1.585 -1.535	>0.050
M71222-005CSM-002	1.564-1.552	0.012	>1.585-1.535	>0.050
M71202-005CSM-004	1.565-1.553	0.012	>1.585-1.540	>0.045
M71171-001ISO-004	1.568-1.558 1.562-1.551	0.011	1.590-1.538 1.575-1.538	0.045

These talc/chrysotile intergrowth photomicrographs visually demonstrates that there is clearly a significant BIR difference between chrysotile and fibrous talc, or talc plates on edge. In my opinion, this just further validation that MAS is not misidentifying fibrous talc as chrysotile.

MAS Method of BIR Calculations

The way MAS calculates the BIR when there is a range of RI's for both the gamma and alpha direction, MAS subtracts the high μ value from the high γ value, then subtracts the low μ value from the low γ value. This BIR calculation has been attacked by both Dr. Sanchez and Mr. Seagrave where they say I am doing wrong, because the ISO 22262-1 PLM states that one should subtract the lowest μ value from the highest γ value. Nowhere in the BIR section in the ISO 22262-1, does it state that to determine the BIR, you subtraction the lowest alpha from the highest gamma.

Where they get that idea is from the glossary section of the ISO method, where it states Birefringence is the “quantitative expression of the maximum difference in refractive index due to double refraction. It does not state that the lowest alpha is subtracted from the highest gamma, nor does it state that in the actual methodology section of the protocol, Section 7.2.3.7.2.

For the determination of the BIR, Section 7.2.3.7.2. method describes how this is done under cross polar conditions where you observe the interference colors for first order, second order and third order as shown in the Michael Levy interference color chart. It is the observation of the interference color that determines the BIR where the PLM analyst will then record if it's Low, Medium or High, or at times, can be recorded as Low to Medium or Medium to High. There is no calculation numerical value by this method.

An example of the numerical calculation of the BIR for chrysotile can be found in the EPA R93-600 method shown in Table 2.2. For chrysotile, this Table provides the RI's for four referenced chrysotile bundles, where each bundle as a range for both gamma and alpha, as well as a calculated range for the chrysotile BIR. For the following Table 11, a comparison is made for the calculation of the reference BIRs to chrysotile RI examples by subtraction the highest alpha from the highest gamma and the lowest alpha to the lowest gamma. These results will be compared to Sanchez and Seagrave method of subtracting the lowest alpha from the highest gamma.

Table 11
Comparison of EPA BIR Calculations
To the Sanchez & Seagrave Method

Refractive Indices	EPA Calculated BIR		Refractive Indices	Sanchez/Seagrave Calculated BIR	
α 1.493-1.546 γ 1.517-1.557	1.557-1.546 = 0.011 1.517-1.493 = 0.024	Avg. 0.017	1.493-1.546 1.517-1.557	1.557-1.493 = 0.064	0.064
1.532-1.549 1.545-1.556	1.556 -1.549 = 0.007 1.545 -1.532 = 0.013	Avg. 0.010	1.532-1.549 1.545-1.556	1.556-1.532 = 0.023	0.023
1.529-1.559 1.537-1.567	1.567 - 1.559 = 0.008 1.537- 1.529 = 0.006	Avg. 0.007	1.529-1.559 1.537-1.567	1.567-1.529 = 0.038	0.038
1.544-1.553 1.552-1.561	1.553 - 1.561 = 0.008 1.552-1.561 = 0.011	Avg. 0.010	1.544-1.553 1.552-1.561	1.561-1.544= 0.017	0.017

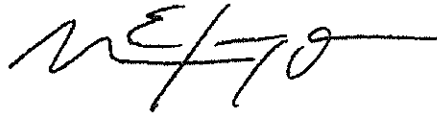
Using the EPA method, the BIR range was 0.007 to 0.017, with an overall average of 0.011 which is in the Low range to lower end of Medium range, which is consistent with chrysotile.

On the other hand, using the Sanchez/Seagrave BIR calculation method, the calculated BIR range is 0.017 to 0.064 with an average of 0.036. Which is not even close for what is expected for chrysotile. The method that we and the EPA used for the calculation of the BIR, is also the

method that the Deere, Howie and Zussman used in their publications for minerals that have double refraction.

I have not been able to locate one reference for BIR calculations for when you have a range of RI's that you would calculate the RI's as Sanchez and Seagrave suggests. It is my opinion that the evidence shows that the only correct method for the determination of BIR calculations, when you have a range of RI's for either gamma and or alpha, that you follow the EPA or Deer, Howie and Zussman calculation method. In my opinion, this data shows that the method that Sanchez and Seagrave state that should be followed, for the BIR calculation, is completely wrong.

The opinions I have expressed in this report are all held to a reasonable degree of scientific certainty.



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